Name _____ Class _____ Date _____ AF

Molar Mass of Butane

Process Objectives

- To identify the variables needed for determining the molar mass of a gas.
- To measure the volume of gas collected by indirect methods.

Learning Objectives

- To understand the importance of correcting an experimental gas volume to the STP volume.
- To determine the molar mass of butane by using experimental data and previously learned equations.

Introduction

In this experiment you will determine the molar mass of butane, the gas that is used as a fuel in inexpensive disposable lighters and in fuel canisters for camping stoves and lanterns. Because butane gas is insoluble in water, it is collected by displacement of water. The partial pressure of the butane gas collected is calculated by using Dalton's law of partial pressures. The general gas law is used to correct for pressure and temperature. For additional information see Chapter 11, Section 11.3 in your text.

Butane, a member of the hydrocarbon series, occurs naturally in petroleum from which it is separated by fractional distillation. It is used not only as a fuel but also in the manufacture of synthetic rubber.

Safety

Take the necessary precautions before beginning this experiment. Wear safety goggles, apron, and gloves. Read all safety cautions in your procedures and discuss them with your teacher. It is important to use good safety techniques while conducting experiments. See pages 8 through 11.

Apparatus

Erlenmeyer flask, 250 mL
glass plate
barometer (classroom)
gas collecting trough
thermometer
plastic tubing

Materials

butane lighter

Record Your Observations

Where instructed in the procedures, record your observations in your Data Table.

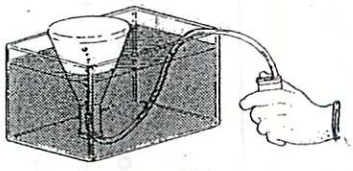

Figure 15-1

Strategy for Identifying
Refer to Dalton's law of partial pressures and the general gas law to determine which variables must be quantified in order to calculate molar mass.

Procedures

CAUTION Butane is very flammable. No flames should be used in the room while this experiment is in progress. Butane gas is toxic. None of it should be allowed to escape into the room.

1. Fill a 250 mL Erlenmeyer flask completely full of water. Measure the quantity of water in the flask by pouring the water into a graduated cylinder. Now refill the flask and cover the top with a glass plate.
2. Fill a trough with water. Carefully invert the flask in the trough without getting any air bubbles in the flask.
3. Determine the mass of a butane lighter.
4. Attach a 20 cm length of plastic tubing to a butane lighter and hold the free end beneath the mouth of the inverted flask. Press the release button of the lighter making sure the bubbles go into the flask. Collect about 250 mL of gas. See Figure 15–1.
5. Remove the tubing from the lighter. Determine the lighter's mass.
6. Raise or lower the flask until the water levels inside and outside are equal.
7. Measure the temperature of the water in the trough.
8. Put the glass plate over the top of the inverted flask. Turn it upright and take it to the hood to release the gas.
9. Measure the volume of water remaining in the flask. Record the volume in your Data Table.
10. Record the barometric pressure.
11. From the table "Water-Vapor Pressure" on page 223 of this laboratory manual find the vapor pressure of water at the appropriate temperature.

Data Table

Initial mass of lighter	_____	g
Final mass of lighter	_____	g
Volume of flask	_____	mL
Volume of water in flask after gas is released	_____	mL
Temperature of water	_____	°C
Barometric pressure	_____	mm Hg
Vapor pressure of water	_____	mm Hg

Strategy for Measuring
The volume markings that are shown on most Erlenmeyer flasks are only approximate and not suitable for gas measurements. The large volume of gas collected in this experiment is measured by difference. The total amount of water contained in the flask and the amount remaining are measured. The difference is the volume taken up by the gas.

Calculations

1. Calculate the volume of gas collected.

2. Correct the barometric pressure for the vapor pressure of water.

3. Calculate the temperature of the water bath in K.

4. Calculate the mass of the gas released into the cylinder from the mass of the lighter before and after the collection.

5. Convert the volume of the gas to liters.

6. Convert the volume of the gas to STP by correcting for pressure and temperature.

7. Calculate the density of butane gas at STP.

8. Calculate the molar mass of butane.

9. Obtain the accepted value for the molar mass of butane from your teacher and calculate your percent error.

Calculations Table		
Volume of gas collected	_____	mL
Partial pressure of butane	_____	mm Hg
Temperature in K	_____	K
Mass of gas collected	_____	g
Volume of gas in liters	_____	L
Volume of gas at STP	_____	L
Density of gas	_____	g/L
Percent error	_____	%

Question

1. Why is it necessary to raise or lower the cylinder until the water levels inside and outside are equal?

_____

_____

_____

General Conclusions

1. What measurements need to be made in order to determine the molar mass of a gas?

2. Propane (C_3H_8) is another member of the hydrocarbon series. If you want to buy 1000 g of compressed gas to take on a camping trip, would you get more moles of propane or butane?